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REPORT OF SURVEY CONDUCTED AT

LITTON
DATA SYSTEMS DIVISION

VAN NUYS, CALIFORNIA

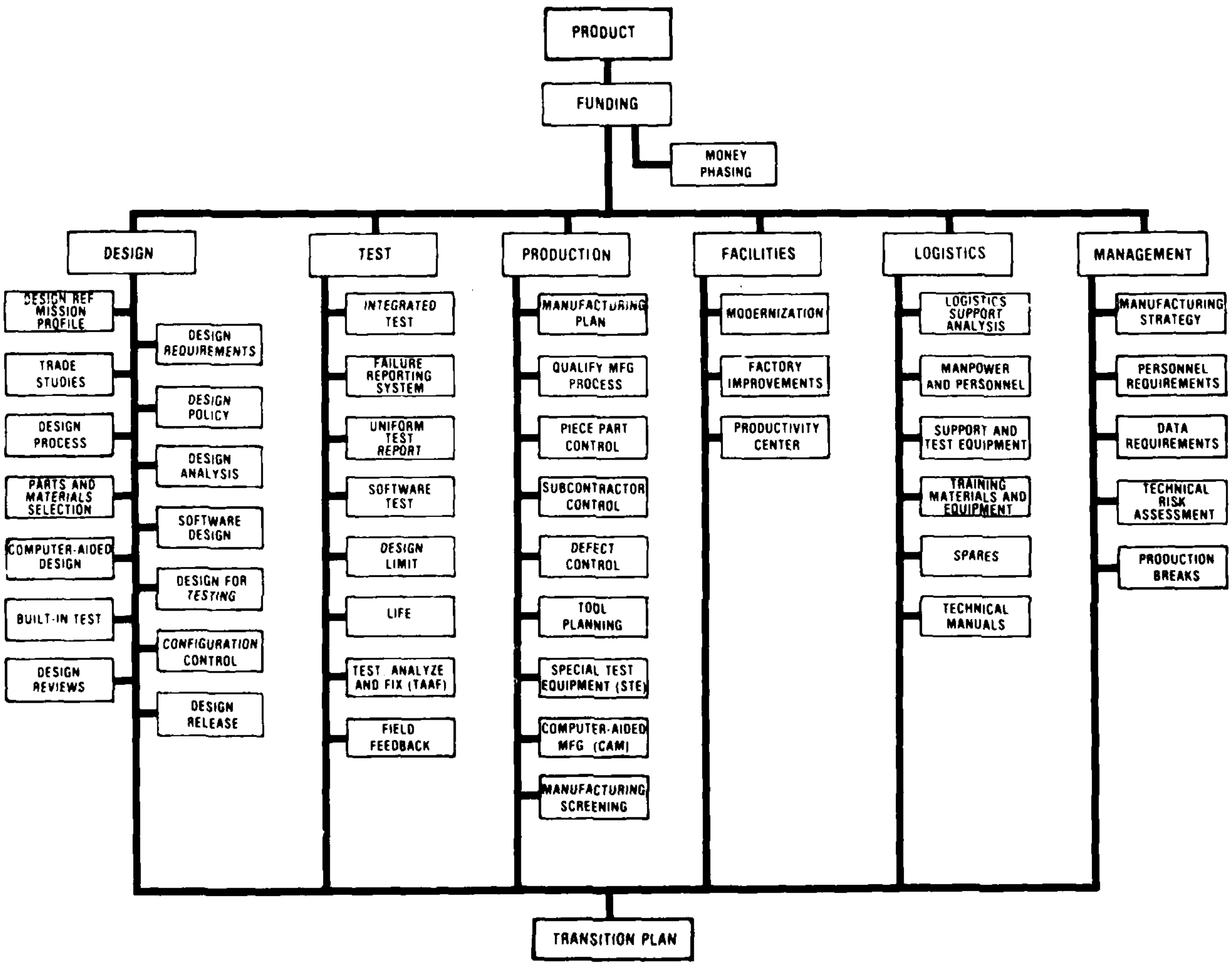
OCTOBER 1988

BMP

DoD 4245.7-M

"TRANSITION FROM DEVELOPMENT TO PRODUCTION"

CRITICAL PATH TEMPLATES



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The purpose of the Best Manufacturing Practices (BMP) survey conducted at this facility was to identify their best practices, review manufacturing problems, and document the results. The intent is to extend the use of progressive management techniques as well as high technology equipment and processes throughout the U.S. industrial base. The actual exchange of detailed data will be between contractors at their discretion. A company point of contact is listed in the report

The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

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SECTION 1

EXECUTIVE SUMMARY

The Best Manufacturing Practices (BMP) team conducted a survey of Litton, Data Systems Division (DSD), Van Nuys, California. The purpose of the survey was to review and document the best practices and potential industry-wide problems at Litton DSD. The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.

Litton DSD is integrating their CAE tools and systems. These CAE/CAD systems are further planned to be integrated with CAM and logistics support systems.

There are many significant aspects of the software design process. Software development follows the incremental life cycle design process. Testing is done at the unit code level. Integration testing is also extensively performed. Design changes are supported by design papers, where requirements are defined and tasks are thoroughly analyzed. Required customer decisions are highlighted and design impacts are performed. Various software development tools are being developed or are being evaluated to augment the design process.

Manufacturing technology development is being initiated with the rack assembly and shelter modification automation projects. This development work, when completed, should complement the existing production efforts.

SECTION 2

INTRODUCTION

2.1 SCOPE

The purpose of the Best Manufacturing Practices (BMP) review conducted at Litton, Data Systems Division (DSD) was to identify best practices, review manufacturing problems, and document the results. The intent is to extend the use of high technology equipment and processes throughout industry. The ultimate goal is to strengthen the U.S. industrial base, solve manufacturing problems, improve quality and reliability, and reduce the cost of defense systems.

To accomplish this, a team of DoD engineers reviewed Litton DSD in Van Nuys, California, to identify the most advanced manufacturing processes and techniques used in that facility. Manufacturing problems that had the potential of being industry wide problems were also reviewed and documented for further investigation in future BMP reviews. Demonstrated industry wide problems are submitted to the Navy's Electronics Manufacturing Productivity Facility (EMPF) for investigation and resolution.

The review was conducted on 18-21 October 1988 by a team of DoD personnel identified in Appendix B of this report. Litton DSD is primarily engaged in design, development, and production of command and control systems.

The results of BMP reviews are being entered into a database to track best practices and manufacturing problems. The information gathered will be available for dissemination through an easily accessible central computer. The actual exchange of detailed data will be between contractors at their discretion.

The results of this review should not be used to rate Litton DSD among other defense electronics contractors. A contractor's willingness to participate in the BMP program and the results of a survey have no bearing on one contractor's performance over another's. The documentation in this report and other BMP reports is not intended to be all inclusive of a contractor's best practices or problems. Only selected non-proprietary practices are reviewed and documented by the BMP survey team.

2.2 REVIEW PROCESS

This review was performed under the general survey guidelines established by the Department of the Navy. The review concentrated on the functional areas of design, test, production, facilities, logistics, and management. The team evaluated Litton DSD policy, practices, and strategy in these areas. Furthermore, individual practices reviewed were categorized as they relate to the critical path templates of the DoD 4245.7-M, "Transition From Development To Production." Litton DSD identified potential best practices and potential industry wide problems. These practices and problems and other areas of interest identified were discussed, reviewed, and documented for dissemination throughout the U.S. industrial base.

The format for this survey consisted of formal briefings and discussions on best practices and problems. Time was spent on the factory floor reviewing practices, processes, and equipment. In-depth discussions were conducted to better understand and document the practices and problems identified.

2.3 NAVY CENTERS OF EXCELLENCE

Demonstrated industry wide problems identified during the Best Manufacturing Practices surveys may be referred to one of the Navy's Centers of Excellence. They are:

Automated Manufacturing Research Facility (AMRF)
Gaithersburg, MD

Electronics Manufacturing Productivity Facility (EMPF)
Ridgecrest, CA

Metalworking Technology Incorporated (MTI)
Johnstown, PA

2.4 LITTON DATA SYSTEMS DIVISION OVERVIEW

Litton DSD maintains major facilities for manufacturing and testing, totaling 285,000 sq. ft., at its headquarters in Van Nuys, California, and at two plants in Colorado Springs, Colorado. The Division employs approximately 3,000 personnel, with 200 involved in manufacturing in Van Nuys and 300 in Colorado Springs. The Division is fully equipped to produce the following types of items to military specifications: two-sided printed circuit boards, multilayer boards (MLB) (480/month), printed wiring board assemblies (15,000/month), power supplies (400/month), cables and harnesses, wire wrap backplanes (400,000 wraps/month), sheet metal fabricated and welded items, milled items, major electronic units (65/month), shelter systems (2/month), and hybrid circuit assemblies (75,000/year).

Since 1980, Litton DSD has produced/procured, assembled, and integrated over 420 command and control (C^2) shelters and produced approximately 1,250 intelligent terminals, 890 communications processors/other electronics equipments, 35 target detection and tracking equipments, and 960 aircraft processors/electronics equipments. Major production programs have included the U.S. and NATO AN/TSQ-73 air defense system, Saudi Arabian Air Defense Forces Command C^3 system, AN/GSG-10 TACFIRE, AN/PSC-2 Digital Communications Terminal (DCT), AN/TTC-39A/MSE L3212A processors, CV-3682/UPX and CV-3912/UPX Radar Beacon Digitizer (RBD), E-2C L304 computer-programmer, and F-15 IFF Reply Evaluator.

The 126,300 sq. ft. Van Nuys, California, facility provides centralized management and material procurement. It is used to fabricate limited quantity manufacture items and also those items which benefit from close proximity to the Design Engineering organization. This facility includes a 4,300 sq. ft. receiving inspection area which supports all facilities; a 6,000 sq. ft. shop which produces MLBs with up to 15 circuit layers; a 4,400 sq. ft. circuit card assembly (CCA) and test area; a 2,200 sq. ft. power supply assembly and testing area; and a 10,000 sq. ft. sheet metal fabrication and machine shop which includes two Numerically Controlled (NC) mills, three conventional mills, and an engine lathe.

The 73,700 sq. ft. Fillmore facility in Colorado Springs, Colorado, is used for planning, manufacturing, and testing all recurring production of circuit card and power supply assemblies, high volume units, cables and harnesses, major units, and major systems. A 13,000 sq. ft. area is dedicated to shipping, receiving, component preparation (20 workstations), and stores. CCAs are assembled and tested in a 13,500 sq. ft. area; operations include automask, flow soldering, in-circuit board testing, and conformal coating. A 4,400 sq. ft. wire wrap and harness area provides three fully automatic and five semiautomatic wire wrap machines with a total capacity of 1,950 wires per hour. An adjoining 2,300 sq. ft. wire wrap area includes 28 workstations and 13 strippers, and a 2,000 sq. ft. unit assembly area provides 27 workstations. A 5,000 sq. ft. power supply assembly and testing area includes a computer-controlled power supply tester.

The 84,600 sq. ft. Powers facility in Colorado Springs, Colorado, produces thin-film and thick-film hybrid components to support other manufacturing facilities and original equipment manufacturer (OEM) sales. It also produces and tests the Rapid Deployment Systems (RDS) equipment and will be fabricating, assembling, and testing the AN/TYQ-23 Tactical Air Operations Modules (TAOM) systems. A recent expansion will enable production of one AN/TYQ-23 Operator Console Unit (OCU) each day, and production was also upgraded in mid-1988 to produce 150 AN/PSC-2 DCTs per month. The microelectronics area equipment includes auto wire bonders, a computerized memory tester, pattern artwork screening, an automatic leadless chip carrier (LCC) pick and place machine, a helium leak tester, clean room operations (Class 100,000), an infrared solder reflow machine, and environmental testing chambers.

2.5 ACKNOWLEDGEMENTS

Special thanks are due to all the people at Litton DSD whose participation made this survey possible. In particular, the BMP Program acknowledges the special efforts of Mr. Allen E. Powers, President of Litton DSD, for enabling this survey to occur. Additionally, thanks to Mr. Jack Harding, Vice President and Chief Scientist, for assisting in developing the framework of this survey.

2.6 LITTON DSD POINT OF CONTACT

While the information included in this report is intended to be descriptive of the best processes and techniques observed at Litton DSD, it is not intended to be all inclusive. It is anticipated that the reader will need more detailed data for true technology transfer.

The reader is encouraged to contact Litton DSD directly for the purpose of sharing or transferring technology. Any exchange of technology resulting from such a contact is strictly voluntary and at the discretion of Litton DSD.

The Litton DSD point of contact for the Best Manufacturing Practices Program is:

Mr. Lou Kelly, Jr.	Litton Data Systems
Director, Special Programs	8000 Woodley Avenue
(818) 901-2600	P.O. Box 7601
	Van Nuys, CA 91409-7601

His cooperation, time, and quality of effort in preparation and hosting of this survey at Litton DSD and participation in the Best Manufacturing Practices Program is greatly appreciated.

SECTION 3

BEST PRACTICES

The practices listed in this section are those identified by the BMP survey team as having the potential of being among the best in the electronics industry.

3.1 DESIGN

CHANGE CAUSE MEASUREMENT

Litton DSD has instituted an analytical effort called "Change Cause Measurement" to identify problems in the hardware design processes that cause expensive technical changes after design release. The effort is a problem (cost) avoidance process which measures the health of the design process and increases engineering awareness. High value changes are categorized, analyzed, and a problem avoidance statement is made. A summary report is prepared for the engineering vice-president and staff for consideration and authorization to make design process changes. Tools are provided to recognize the common cause of multiple changes. The end product is increased productivity.

DRAWING BAR CODE STATUS SYSTEM

The drawing bar code status system is a method of recording and maintaining drawing status by using bar code labels and a bar code reader.

Drawing numbers printed as bar code labels are affixed to drawings and/or the drawing work folders. As the drawing travels through Engineering, Drafting, Check, and Release, the status is recorded on a portable bar code reader. The bar code reader is downloaded to a Personal Computer (PC) daily. This data is processed by a computer into various report formats to be viewed on the PC screen or in hard copy.

RELIABILITY MODELING PROGRAM

Litton DSD Product Effectiveness Department has implemented an active Reliability Modeling Program. Key elements of this program are the Parts Stress Reliability Predictions (PRED) and the Reliability, Maintainability, and Availability (RMA) Modeling programs.

The PRED program is an IBM PC XT/AT compatible program, written in BASIC, that performs circuit card, or module, level reliability predictions in accordance with MIL-HDBK-217, Versions C Notice 1 through E. The required input to this program is the module's parts list, and the output is the predicted reliability of the module. A key feature of this program is the Dynamic Library which includes files for integrated circuits, capacitors, and semiconductors. The library contains over 400 part types and their inherent internal quality factors and stress values. The program allows for the interactive development of additional part types, which then become part of the permanent library. The program also allows for on-line change of ambient operating temperatures, quality factors, and stress values. This allows the system designer to play "what if" games to optimize module design.

The RMA Modeling Program is also an IBM PC XT/AT compatible BASIC program which performs system level RMA calculations in accordance with the requirements of MIL-STD-756. The program provides a means to rapidly create and exercise series and/or redundant mathematical models (with or without on-line repair) to determine overall unit/system reliability, maintainability, and availability parameters. The program also has the capability of re-apportioning any or all elements of the model in order to achieve stringent system specifications. When performing this re-apportionment function, new element values are calculated and assigned to the baseline elements. This provides the system designer with new "design to" parameters to meet overall system requirements. An additional feature allows re-apportionment only for equipment over which the designer has control, while retaining the original values for "frozen" designs or subcontractor items.

Both programs automate otherwise cumbersome and time consuming processes. As stated earlier, the PRED program automates MIL-HDBK-217 reliability predictions. The RMA Modeling Program does the same for MIL-STD-756 predictions. These tools are internally useful in almost all of Litton's modeling applications, including quick turn-around assessments of system designs against specified RMA requirements, as well as in reliability and RMA prediction reports. Against a baseline system design, individual element values and/or overall configuration changes can be easily and rapidly made to optimize system performance. The use of these programs greatly enhance Litton's ability to perform timely and accurate RMA predictions and allow an iterative process between design and reliability engineers to optimize Litton DSD designs.

COMPONENT STANDARDIZATION

Litton DSD has recently expanded their Component Standardization Program, aimed at limiting the types of components a designer can select. The program initially will focus on integrated circuits.

Parts selected must be on a MIL-STD qualified parts list, a DESC approved part, or have existing Litton DSD specifications. If none of these criteria are met, the design engineer must submit a Component, Material, or Process Engineering Request (COMPER) to Litton's Component Standardization Board (CSB) for approval. The CSB evaluates the request, considering such factors as the existence of a manufacturer's detail drawing on the part, the applicability of an existing Qualified Parts List (QPL) part or approved Litton part for the proposed application, the number of sources able to provide the part, the amount of testing required for full approval of the proposed part, and the need for vendor surveillance.

In addition, Litton has imposed the requirements that specifications for all new integrated circuits approved for use by the CSB be written in Standard Military Drawing (SMD) format. This process will insure that there is one part number used by all Litton divisions, database control to minimize the creation of specifications, generation of standardized microcircuit test software, and standardization on receiving inspection testing.

This approach has two attractive advantages: a reduction in the proliferation of specifications and procurement cost advantages.

SOFTWARE DEVELOPMENT PROCESS

The software development process is implemented at Litton DSD with the prime objective of building quality into their software products. Although the approach which they follow is specifically used on the Marine's Tactical Air Operations Control (TAOC) and Air Force's Modular Control Equipment (MCE) projects, it reflects the company's overall concept of software engineering. The major activities are modeled over the software development cycle of DOD-STD-2167. This cycle includes the following activities:

Planning/Requirement Analysis
Design
Implementation
Unit Testing
Integration
System Testing

The process follows an incremental development cycle, which allows all of these activities to be in progress at the same time with each of the activities addressing a different increment of the software changes.

The projects are supported by an extensive set of tools, many developed by Litton. Examples are the In-Plant Simulator which supports the test activities by simulating the radar and communications inputs of the systems and the UNITESTER, which supports the off-line evaluation of the code.

The following list identifies key elements of the development process:

The partitioning of the software into many small functions which can be designed, coded, and tested independently.

The documentation of the design using informal design papers, which provide complete description of the design solution and also identify the reasons why the solution was chosen.

The use of frequent internal and customer design reviews to evaluate the design.

The use of software metrics tools to evaluate the progress on the development efforts.

The use of software metrics tools and models to evaluate the usage of critical resources such as computer memory and processing capacity.

SOFTWARE QUALITY PROGRAM

Litton DSD has established a software quality program, which is integrated into all software development activities and is independent from the development organizations through the management level of vice-president. This provides the organizational freedom to permit objective evaluations and to initiate and verify corrective actions. The objectives of the Software Quality Assurance Activity are: (1) to evaluate all software products to assure that the software product complies with the requirements and that the software product adheres to the software plans; (2) to assure quality of the software documentation; i.e., compliance to company software standards and policies, compliance to government requirements, and consistency of the document reviewed with higher or lower level documents; (3) to assure quality of processes to develop software; and (4) to assure quality of support software and sub-contracted software.

SOFTWARE ENGINEERING TOOLS

Under the Research and Development Program for the software development groups, Litton DSD is implementing the use of software engineering tools for new software development environments.

The efforts are concentrated into two areas:

> The ADA integration software development environment, which is implemented with a Digital Equipment Corporation VAX Toolset that includes: Integrated Database, Language Sensitive Editor, Symbolic Debugger, ADA Runtime Library, Code Management System, Source Code Analyzer, Performance and Coverage Analyzer, Test Manager, and VAX ADA Compiler.
>
> A Computer Aided Software Engineering (CASE) system, which includes CARDtools (from Ready Systems) to support full software development life cycle, automated document generation under DOD-STD-2167A, traceability and completeness functions, design language, structured design graphics tools, and performance verification tools.

Litton is currently training personnel on the use of these tools and is using these tools on R&D projects. Litton will be introducing the tools into new projects.

COMPUTER AIDED ENGINEERING HARDWARE AND SOFTWARE

Litton DSD has integrated various software packages and hardware platforms to address design and analysis of digital circuits using electronic Computer-aided Engineering (CAE) tools. The hardware and software has been selected to allow transfer of the electronic database from process-to-process without requiring manual re-entry of data.

Schematic capture is performed using software from Case Technology running on Compaq 386/20 personal computers running EGA graphics. Netlists compatible with HHB Softron's CADAT simulator are extracted from the Case database. CADAT is first used to perform functional simulation to determine on a gross basis whether the design provides the responses desired by the engineer.

CADAT is next used to perform a performance evaluation, a more detailed form of simulation, to determine how the design performs over a specified range of component tolerances. CADAT is also used to perform fault simulation, which determines the percentage of fault converage achieved using a given set of test vectors. The CADAT package also translates the test vectors into the format needed by a Schulumberger Factron ATE tester.

These simulation processes are accelerated through use of a Logic Acclerator from HHB Softron. A Hardware Modeler from HHB Softron is used to supply the functional behavior of VLSI components whose operations cannot be described through Boolean or gate level models.

A file server with 2 Gb of storage from Sun Microsystems is shared by the current contingent of workstations.

After this thorough front-end design and analysis process is completed, data is once again extracted from the Case schematic database in a format needed by Litton's Printed Wiring Board (PWB) layout process. Currently, Litton performs manual placement of PWBs because their product line has allowed standardization to just three card sizes. Routing of the PWB, performed remotely on a computer located at Litton Computer Services, is accomplished with software written by Litton. More highly integrated systems from Intergraph, Racal-Redac, and Mentor Graphics will be evaluated shortly. Prior to the placement and routing phases, various electrical rule checks are also performed with Litton originated software.

The results of routing the PWB, together with the applicable placement template, are next transferred electronically to Intergraph CAE Systems for prepration of assembly drawings. Parts list information is also transferred electronically to Operations (Manufacturing) for preparation of assembly instructions using Ventura Publisher software running on Compaq 386/20 personal computers.

All CAE/Computer-aided Design (CAD)/Computer-aided Manufacturing (CAM) equipment at Litton DSD facilities in California and the Colorado Manufacturing Facilities are interconnected using an Ethernet network. The network is hierarchically structured using bridges to isolate local traffic. Long term plans call for a wide-band network.

ENGINEERING CHANGE ORDER PROCESSING AND ANALYSIS

Litton DSD has achieved a significant reduction in the average time to process Engineering Change Orders (ECOs). This has been achieved by using senior personnel to screen Engineering Change Requests (ECRs). Poorly conceived, unnecessary, or poorly written ECRs are quickly rejected and advice is provided to the originator. Desirable ECRs, whose incorporation are not immediately required, are held in abeyance until a more major need requires modification of the design.

Litton DSD claims that the amount of time required to process an ECO has been cut from approximately 120 days to an average of 40 days. The front-end review process has also substantially reduced the number of ECOs presented to the Change Review Board.

Another key aspect of this procedure is determining when a change should be incorporated in the manufacturing flow. Manufacturing is given the opportunity to recommend a cut-in point for incorporating a change. Space is provided on the ECO form for their recommendation. This also gives them early visibility of forthcoming changes. Program management retains final authority over when a change will be incorporated.

Data on the time required to process ECOs through the various responsible organizations is accumulated and analyzed to detect undesirable trends. The results of this analysis is periodically presented to the vice-president of Litton DSD.

3.2 TEST

TEST DOCUMENTATION TRACEABILITY

Litton DSD has developed a computer program for test documentation traceability. The program identifies all contract test requirements by breaking down each contract requirement into sub-requirements and then allocates responsibility, individual system test, and specific test procedure steps. The program enables cross referencing of contract requirements to specific test procedure steps, maintaining the day-to-day test status and summary reports.

SOFTWARE UNIT AND INTEGRATION TESTING

The unit testing process evaluates all new or modified lines of code using a tool called the UNITESTER. The tool supports CMS-2, which is the language used on the TAOC and MCE Projects. The testing is performed in an off-line environment and focuses on the execution of code at the procedure (unit) level. UNITESTER commands are entered to define the test inputs and the expected outputs. The unit is compiled and executed under the UNITESTER. The tool compares the outputs of the test run to the expected outputs and automatically generates a test report to record the results. When errors are detected, the code is corrected and the test is rerun.

Integration Testing is dynamically and effectively conducted at Litton with a continuous back and forth exchange between the coding group and the integration team. This testing provides for a rapid detection and correction of coding and design errors. Integration testing focuses on the evaluation of new and modified functions. Pre-established test plans and procedures are generated for each function. The tests are conducted using inputs generated by the In-Plant Simulator. Test results are verified by checking the requested displays and printouts and by analyzing recorded data. Trouble reports are written to record problems and to propose coding corrections. The coding group updates the code to correct the problems and resubmits it to the integration team for further evaluation.

3.3 PRODUCTION

MANUFACTURING MANAGEMENT SYSTEM

Starting with a basic IBM software package, Litton DSD has added numerous modules to create a highly functional Operations Department planning, tracking, and control system, which is used to control manufacturing in three different plant locations. Major functions include, scheduling/requirements systems, material, manufacturing, project status and reporting, product assurance and configuration tracking, and forecasting systems.

The above mentioned systems also interface, either directly or indirectly, with other reporting systems such as operations requirements and scheduling system, program status reporting, operations work-in-process, labor, and inventory system. Accounting, purchasing, and design engineering programs are also interfaced.

A weekly report, called the Manufacturing Engineering Status and Action (MESA), is generated which provides data by part number, planning status, raw material requirements, plant build locations, production start dates, special tooling, revision level, assigned engineer, etc.

The overall computer information system provides a reasonably complete manufacturing management tool.

COMPUTER AIDED MANUFACTURING

Computer aided manufacturing engineering utilizes the CAD database for developing and maintaining tooling. The elimination of hard copy drawings saves time and insures that the latest revisions are always available, eliminating errors due to building to the wrong revision. The CAM system is utilized to develop NC programs for punching, milling, and drilling. The CAD database is also utilized in developing the manufacturing instructions. Each manufacturing operation has been standardized and resides on the CAM system, making the development of manufacturing instructions easy and quick to complete. The facilities layouts for Van Nuys and Colorado Springs are developed and maintained on the CAM system. Using the time management system and the standardized work operation times, the facility layouts can be analyzed to determine the most efficient layout for building products within the available facilities. The CAD/CAM database is integrated throughout all phases of the manufacturing operations.

3.4 FACILITIES

RACK ASSEMBLY AUTOMATION

Litton DSD is currently developing unique systems for automation in 1989. This system will use a seven-axis robotic machine to do rack assembly level machining. Rack detail parts will be fabricated to size using a precision saw with production stops which are quickly and easily adjustable. The details will be assembled in tooling mounted to trunnions for convenience in working on the racks in different positions. The final phase of the rack assembly will include machining of the final hole patterns after assembly using the robotic machine mounted to a special rack workstation table.

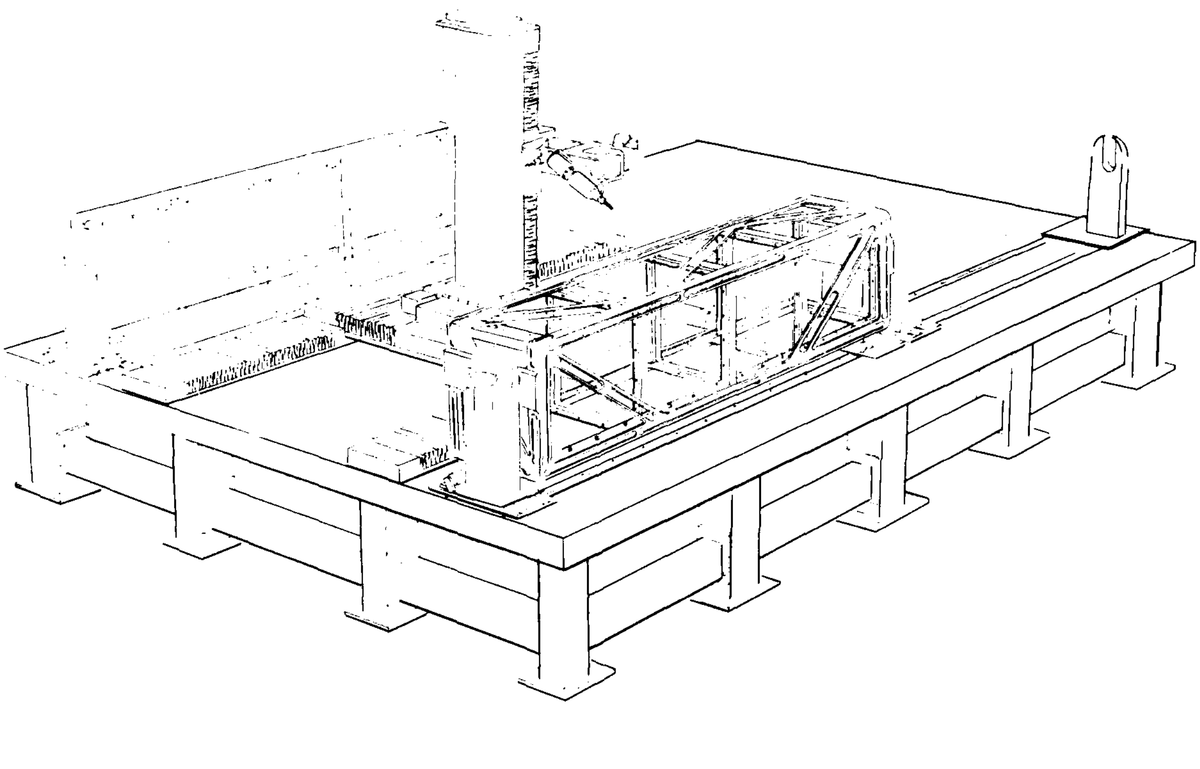

FIGURE 3.4-1: CNC MACHINING OF RACK ASSEMBLIES

SHELTER MODIFICATION AUTOMATION

The same seven-axis robotic machine used for rack assembly will also be used to modify the shelters to accept the racks and for other modification requirements. The machine will be mounted into the shelter and traverse from end-to-end. It will drill holes, rout cavities between the walls for potting, apply the potting compound, and is even capable of interior final spray painting. To support these operations, the shelter itself would be rotated for insertion of the robotic machine.

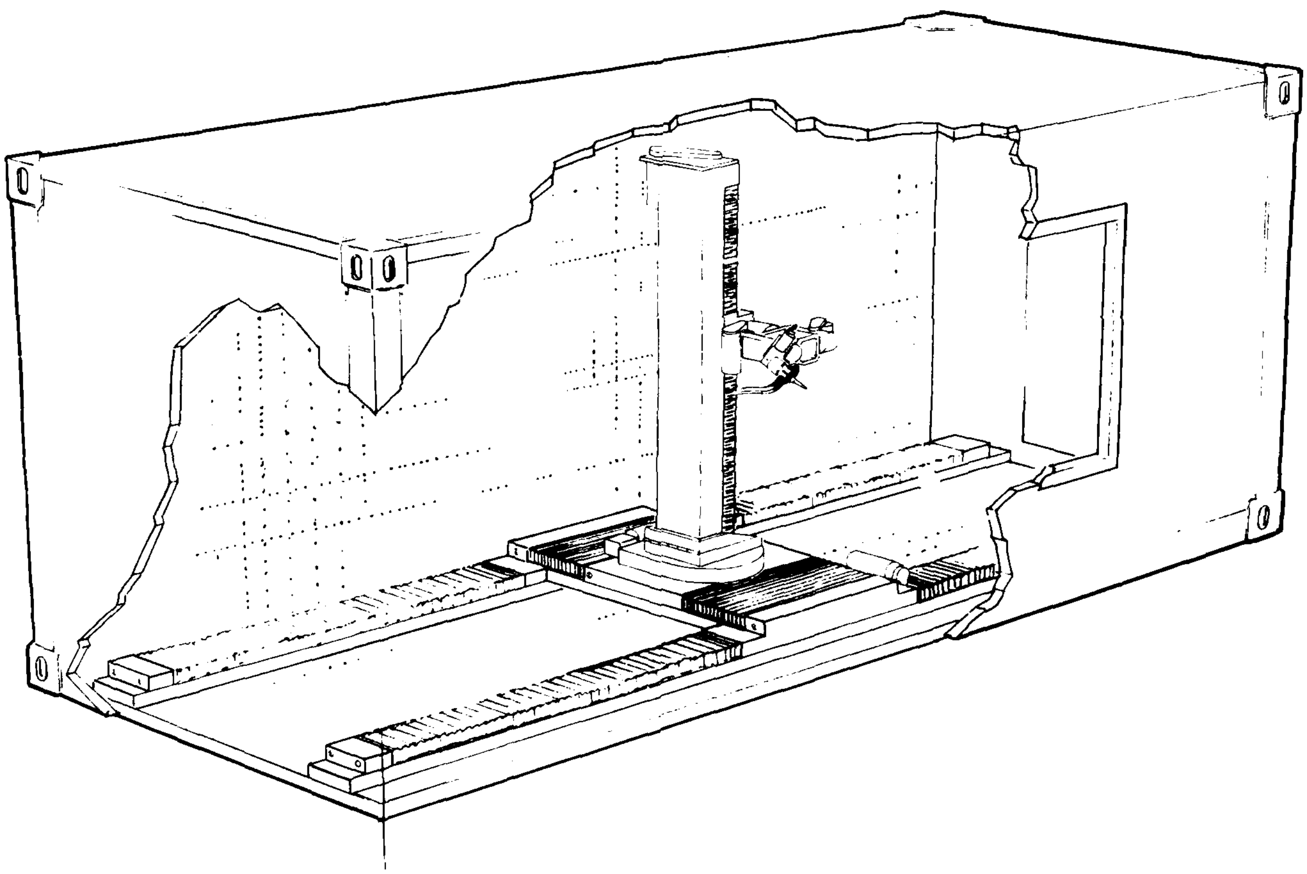

FIGURE 3.4-2: CNC MACHINING OF SHELTER INTERIOR

LASER CABLE ROUTING

During shelter load operations, many cables must be properly routed across the shelter walls and ceiling from the instrumentation rack location to other locations. Much of this work is normally done overhead, a difficult position for workers. With this automation project, the shelter can be rotated so the ceiling becomes the floor, allowing workers to route cables conveniently. By use of a computerized laser director, cable routing instructions stored in memory will be projected directly onto the shelter. A laser scanning system displays the route for each selected harness wire and a technician lays the wire directly in place. The laser director will also be used as an overhead projector for providing harness board information for construction of the harnesses.

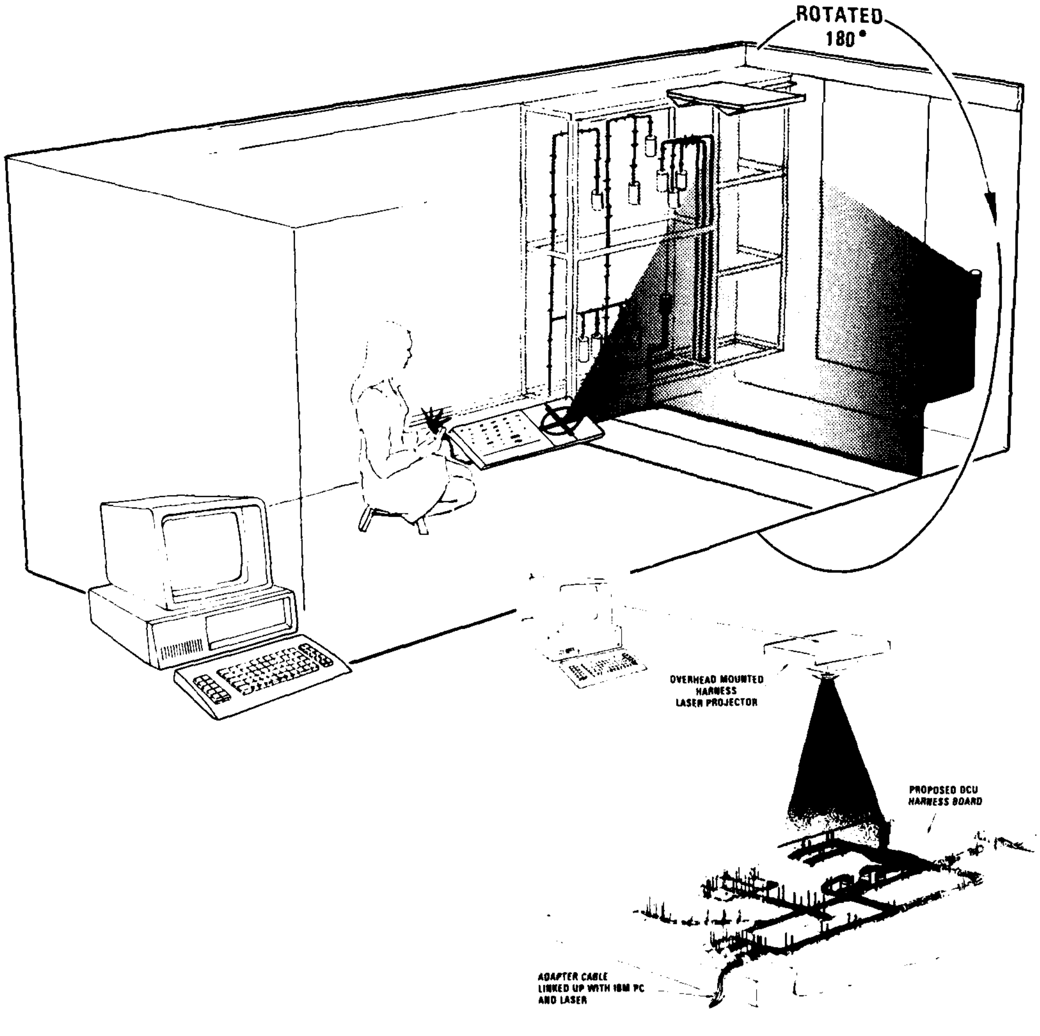

FIGURE 3.4-3: LASER CABLE ROUTING AND HARNESS APPLICATION

OPERATIONS IMPROVEMENTS

Litton DSD is making great efforts to improve the efficiency of their operations. They have invested considerable capital to computerize such processes as procurements, inventory control, and scheduling. They have also invested a great deal in their CAD/CAM systems and incoming parts inspection systems. Using automation for parts inspection, they have experienced a significant drop in failure rates due to malfunctioning parts.

Litton DSD is also actively pursuing efforts to make material handling more efficient and less time consuming. By doing this, they will be able to minimize non-value added costs associated with material flow. In general, they are making a considerable effort to improve factory operations. They are taking a long-term business perspective in an effort to remain competitive in the market place throughout the 1990's.

BAR CODE INVENTORY SYSTEM

Litton DSD has developed an equipment inventory control system to control over 1,500 pieces of Government Furnished Equipment (GFE) and company test equipment. Previous inventories were conducted using a monthly equipment responsibility list to visually find all the equipment. The new systems utilize a portable bar code reader to identify each piece of equipment (including assemblies and subassemblies of large test systems) and to read location (room and table locations). The reader downloads the information into a PC which then updates the inventory database. This database is then uploaded into the larger department inventory record. The key benefits have been greatly reduced human error, lower inventory cost, and the ability to update and locate equipment.

3.5 LOGISTICS

DESK TOP TECHNICAL MANUAL PUBLISHING

Litton DSD Technical Publications Department has implemented desk-top publishing for technical manuals using IBM PC compatible (XT/AT) hardware and commercially available text processing software (XyWrite). Logistic Support Analysis (LSA) repair and maintenance text from the Product Effectiveness Department is transferred to the Technical Publications Department via a Xenix based Local Area Network (LAN). A second LAN ties all the technical writers together, which makes current LSA text available to them in a single database, thus eliminating the delays, errors, and duplications experienced with manual data transfer. The XyWrite software has a built-in programming language that is used to convert the LSA text into the military specifications required format for technical manuals. This has reduced, by approximately 95%, the amount of technical writer time and effort required to convert LSA source information to technical manual format and content. Technical writers and editors can perform their writing and editing responsibilities without printed documents, manual markup of revisions, or manual entry of approved changes. Outline and format generators can be programmed to conform to any military specifications for technical manuals.

Litton DSD has been using this system for nearly three years. Overall, the time and cost of producing technical manuals has been reduced by 30%. The cost of producing technical manual pages generated directly from LSA text data (normally, approximately 20% of a manual) has been reduced by 50%. Since all data is entered by the technical writers, the need for dedicated typists has been eliminated.

Currently, illustrations must be done by graphics personnel and added to the text manually. Future upgrades include linking the Technical Publications system to the engineering CAD system for direct input of engineering drawings and processing into technical manual format.

3.6 MANAGEMENT

TECHNOLOGY TRANSFER AND RESOURCE SHARING

Litton's corporate philosophy is to allow their various divisions to act independently as separate companies. However, they recognize that effective technology transfer and resource sharing between the divisions enhances their competitive position.

To foster technology transfer, an annual Advanced Engineering Symposium was instituted at the corporate level. At these conferences, papers are presented and awards given for the top inventions and ideas of the year within the company. The full benefits of these conferences go beyond the immediate sharing of information. They serve as a meeting ground where experts in various technical disciplines can become acquainted. This leads to a much broader technology transfer at an informal level long after the conference has ended. These conferences were so successful that Software Management and Technology and Electro-Optical Conferences were instituted as well. On March 14, 1989, a corporate-wide meeting will be held with all Divisions attending to exchange ideas on productivity and quality.

As a follow-on to these Corporate Level Conferences, Litton Advanced Electronic Systems Group has expanded the program at the Group Level to include Manufacturing Engineering, ILS, VLSI/VHSIC/ASIC, CAE/CAD/CAM, and Reliability and Quality Assurance Conferences as well.

Litton DSD has also initiated off-site meetings with working level engineers to discuss how the division can best stimulate creativity and encourage the flow of new ideas. This contributes to the environment of open communication evident at DSD.

PROGRAM RISK MANAGEMENT

Litton DSD has implemented a formal risk management system to minimize uncertainty in the technical processes of design, test, and production and to effectively provide better control of transition from development to production. This system provides early identification of risks, a tool for immediate assessment of current project status, and early key indicators of potential success or failure to management at all levels. The system is initiated during the proposal phase and functions throughout development and production.

A disciplined process is used to identify specific risk areas and evaluate each area to determine importance. The techniques applied for risk analysis, evaluation, and management were modeled after the Mk-50 Torpedo risk management system developed by Honeywell Undersea Systems Division. It is based on a system of engineering indicators which can be used effectively to report current program health, to anticipate problems, and to display status to management and customers. System simulation modeling is used to provide forecasts of cost, schedule, and staffing levels for developing strategies and evaluating alternatives.

SECTION 4

PROBLEM AREAS

4.1 LOGISTICS

LSA AND TECHNICAL MANUAL DELIVERY SCHEDULE

Litton expressed a concern that the Logistic Support Analysis (LSA) and technical manual delivery schedules should be synchronized to allow initial completion of LSA documentation prior to the "heavy" technical writing efforts.

4.2 DESIGN

DESIGN REVIEWS AT MAJOR MILESTONES

When software design reviews are scheduled at major milestones, such as the completion of the software performance specification, the large size of the review package coupled with schedule time shortages make it difficult to allocate an adequate review period. Therefore, much of the material is not reviewed and design errors are not detected. A more desirable approach is to have frequent incremental design reviews on smaller design packages. The partitioning of the software changes into small logical groups will allow an incremental review concept to be used. Another benefit of this concept is that other software development activities, such as coding and integration, can start earlier in the project using fully reviewed and approved design material.

4.3 PRODUCTION

COMPONENT SOLDERABILITY

Quality component lead finishes are required to ensure a quality soldering process. Typically, cleaning and pretinning of component leads and use of the component within 120 days is accomplished at Litton DSD to avoid component solderability problems and assure high quality solder connections. The capital investment required for these operations is considerable and will continue until vendors provide components acceptable for use as received.

PART MARKING

Litton DSD is required to mark individual parts with the part number and in some instances with other information, such as revision level. This requirement has added cost, capital investment, and scheduling considerations. The effort required to maintain these markings during the normal manufacturing processes is considerable. The benefits from this requirement may be limited when weighed against the cost to the government and industry to maintain this requirement.

APPENDIX A

TABLE OF ACRONYMS

Acronym	Definition
BMP	Best Manufacturing Practices
CASE	Computer Aided Software Engineering
COMPER	Component, Material, or Process Engineering Request
CSB	Component Standardization Board
DCT	Digital Communications Terminal
DSD	Data Systems Division
ECO	Engineering Change Order
ECR	Engineering Change Request
EMPF	Electronics Manufacturing Productivity Facility
ILS	Integrated Logistics Support
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
MCE	Modular Control Equipment
MESA	Manufacturing Engineering Status and Action
MRSA	Material Readiness Support Activity
OCU	Operator Console Unit
PRED	Parts Stress Reliability Predictions
QPL	Qualified Parts List
RBD	Radar Beacon Digitizer
RDS	Rapid Deployment Systems
RMA	Reliability, Maintainability, and Availability
SMD	Standard Military Drawing
TAOC	Tactical Air Operations Control
TAOM	Tactical Air Operations Modules

APPENDIX B

BMP REVIEW TEAM

Team Member	Agency	Role
Alan Criswell (215) 897-6684	Naval Industrial Resources Support Activity Philadelphia, PA	Team Chairman
Jim Brining (317) 353-7960	Naval Avionics Center Indianapolis, IN	Team Leader Design/Test
Dave Zeph (317) 353-7961	Naval Avionics Center Indianapolis, IN	
Dick Kluesner (812) 854-3849	Naval Weapons Support Center Crane, IN	
Claudia Barton (619) 553-3376	Naval Ocean Systems Center San Diego, CA	
Larry Robertson (812) 854-1694	Naval Weapons Support Center Crane, IN	Team Leader Production/Facilities
Bob Bixler (619) 553-1961	Naval Ocean Systems Center San Diego, CA	
Jerry Sergeant (309) 782-5617	U.S. Army Industrial Engineering Activity Rock Island, IL	
CDR Rick Purcell (202) 692-3422	Office of the Assistant Secretary of the Navy (S&L) (RM&QA-PI) Washington, DC	Team Leader Management/Logistics
Mark Dean (812) 854-3849	Naval Weapons Support Center Crane, IN	

APPENDIX C

BMP PROGRAM AND MIS INFORMATION

Information relating to the Best Manufacturing Practices Program or copies of BMP survey reports may be obtained by contacting the following:

Office of the Assistant Secretary of the Navy
(Shipbuilding and Logistics)
Directorate, Reliability, Maintainability, and Quality Assurance
Production Assessment Division
Attn: Mr. Ernie Renner
Director, Best Manufacturing Practices
Washington, DC 20360-5100
Telephone (202) 692-0121

Information gathered from all BMP surveys is included in the Best Manufacturing Practices Management Information System (BMP-MIS). Additionally, a calendar of events and other relevant information are included in this system. All inquires regarding the BMP-MIS may be directed to:

Director, Naval Industrial Resources Support Activity
Attn: BMP-MIS System Administrator
Bldg. 75-2, Room 209 Naval Base
Philadelphia, PA 19112-5078
Telephone (215) 897-6684